It isn't easy to monitor users without a device using standard Wi-Fi devices. The reflection signals used for device-free tracking are much weaker than the direct-path signal compared to device-based monitoring, making extracting accurate and usable tracking information from the reflection signals more challenging. Additionally, the restricted bandwidth and three antennas found on the majority of commodity Wi-Fi cards make angle-of-arrival (AoA) and time-of-arrival (ToA) based passive tracking too insensitive. With Doppler information, whose resolution is unaffected by the number of antennas or bandwidth, we hope to solve the tracking movement problem in this section.

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100I10n an indoor environment, human movements alter the path length of the Wi-Fi signal reflected from the human body for each pair of transceivers, causing a Doppler frequency shift of the signal. This is the fundamental concept and theoretical basis of our Wi-Fi based device-free tracking system. The phase information of the Channel State Information (CSI) available at the common Wi-Fi receiver can be used to determine the amplitude and direction of the Doppler frequency shift. The velocity and location of the human target are thus linked to the amount of Doppler frequency shift because they affect how quickly the reflection path length shifts. Additionally, we can get the AoA spectrum from CSI, which shows the location (angle) probability of the object. We can then estimate the human velocity, location, and consequently moving trajectory by fusing Doppler frequency shift with the AoA spectrum, accomplishing our objective of precise device-free human tracking with common Wi-Fi devices.

Before the concept can be implemented on common Wi-Fi products, a number of issues must be solved. First off, relative to the carrier frequency, the amount of Doppler frequency shift brought on by human movement is very minimal (less than 100 Hz for a 5 GHz Wi-Fi channel, for example) (5 GHz). Second, each CSI sample has a random phase offset because common Wi-Fi receivers are not perfectly synchronized with the emitter in terms of carrier frequency and time. Doppler frequency shift estimation suffers significantly from a lack of accuracy if this random phase offset is not managed correctly. Third, even with a precise estimation of the reflection signal's Doppler frequency shift, there is no direct connection between the Doppler frequency shift and the target's velocity because the target's velocity also relies on its current location, which is unknown. Last but not least, it is still impossible to determine the absolute trajectory without knowing the precise starting point, even with the goal velocity estimated.